The Time-Dependent Prize-Collecting Arc Routing Problem

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Data Files

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1 Introduction

In the following, we let μ_{tij} be the minimum time for traveling from location i to location j beginning at time t. Let $\mu_{ij} = \min_t \mu_{tij}$. Let $\alpha = \frac{\sum_\Omega \mu_{ij}}{|\Omega|}$ (where $\Omega = \{\mu_{ij}, \forall i, j : i \neq j\}$) denote the average among these.

We let $\sigma[a; b]$ be a random number drawn uniformly from the interval from a to b.

Furthermore, we use $s(k)$ and $t(k)$ to denote the source and target of the k'th prize arc, respectively and use p_k to denote the size of the prize.

2 Format of Data Files

Each instance requires two files: A Road Time Table and a data file.

The files with the Road Time Tables are named for instance "NW25_RTT_time.dat", where "NW" refers to the North-West area and "25" in the number of locations in addition to the depot in the file. Hence this specific instance contains in total 26 locations. These files contains 96 shortest time matrices separated by an empty line. Each matrix is valid for 15 minutes and the first matrix start at time 00:00.

The data files are named for instance "NW25_xi.dat", where "x" is replaced by a capital letter and "i" is replaced by an index. again, "NW" refers to the North-West area and "25" in the number of locations in addition to the depot in the file. The capital letter refers to the class of instances and will be further explained below. To use these instances, the corresponding files with the Road Time Tables should be used. Note, that there may be locations in the Road Time Table files which are not used in a given data file. The times within the Road Time Tables correspond to travel times across the real world road network.

The data files contain the following information:

- Number of locations (in addition to the depot) in the corresponding Road time Table. Note that this number corresponds to the number in the name of both files.
- Number of prize Arcs.
- Start time (the time at which the vehicle starts in the depot). In minutes after time 00:00.
- Duration (the time duration for which the vehicle can work). In minutes after time 00:00.
- Time Limit (the time at which the vehicle must be back in depot). This is the sum of the start time and the duration. In minutes after time 00:00.
- Next, for each Prize Arc on a separate row, the following information is given:
  - Unique index of the prize arc.
  - Start location of the prize arc.

– End location of the prize arc.

– prize of the arc. Integer value.

3 Details on the North-West Instances

There instances are based on data from the area around Manchester.

3.1 A and B instances

For these instances, the source node, $s(k)$, of the k'th prize arc is chosen uniformly at random among the 25 locations, and the target node, $t(k)$, is chosen uniformly at random among the remaining 24 locations.

For the A-instances, the size of the prize is created randomly using the following formula:

$$p_k = \lceil \sigma[0.8; 2.5]\mu_{s(k)t(k)} + \sigma[0.5; 2.0]\alpha \rceil \tag{1}$$

For each A-instance, we have created a corresponding B-instance: For instance A1 this is instance B1, and so forth. The instances are identical except that the prizes of the B-instances are smaller. These are obtained by dividing each prize in the A-instance by $\sigma[2.0; 3.0]$ and rounding.

Further details on the A and B-instances are given here:

Instance	RTT file	No. prizes	Start time	Duration
A1 and B1	NW25	50	420	600
A2 and B2	NW25	50	300	900
A3 and B3	NW25	100	300	900
A4 and B4	NW25	100	180	1200
A5 and B5	NW25	150	0	1440

3.2 C and D instances

In the C-instances, the prize arcs are of short distance. Hence, in general it is possible to include more jobs in these instances than in the A and B instances.

The source and target nodes are chosen uniformly at random among the pairs that respect

$$\mu_{s(k)t(t)} \leq 0,75\alpha \tag{2}$$

In the D-instances, the prize arcs are of long distance. Hence, in general it is possible to include less jobs in these instances than in the A and B instances.

Here, the source and target nodes are chosen uniformly at random among the pairs that respect

$$\mu_{s(k)t(t)} \geq 1,25\alpha \tag{3}$$

The size of the prizes in the C and D instances the is created randomly using the same formula as for the A instances, which is repeated here for convenience:

$$p_k = \lceil \sigma[0.8; 2.5]\mu_{s(k)t(k)} + \sigma[0.5; 2.0]\alpha \rceil \tag{4}$$

Further details on the C and D-instances are given here:

Instance	RTT file	No. prizes	Start time	Duration
C1 and D1	NW25	50	420	600
C2 and D2	NW25	50	300	900
C3 and D3	NW25	100	300	900
C4	NW25	100	180	1200
C5	NW25	150	0	1440

3.3 E instances

In the E instances, the majority of the prize arcs are inbound to five location: 8, 11, 15, 19, and 23. More precisely: With probability $\frac{3}{4}$, the target if selected uniformly at random among these five locations and the source is selected uniformly at random among all locations except the target. With probability $\frac{1}{4}$, both source and target is selected uniformly at random among all 25 locations.

As for the A instances, the prize is determined by the formula

$$p_k = \lceil \sigma[0.8; 2.5]\mu_{s(k)t(k)} + \sigma[0.5; 2.0]\alpha \rceil \tag{5}$$

Further details on the E instances are given here:

Instance	RTT file	No. prizes	Start time	Duration
E1	NW25	50	420	600
E2	NW25	50	300	900
E3	NW25	100	300	900

3.4 F instances

The F instances are large instances based on a road time table with 100 locations. All the F instances are based on a time period of a whole day. Furthermore, we have made extended F instances where the time duration is three whole days.

As for the A-instances, the size of the prize is created randomly using the following formula:

$$p_k = \lceil \sigma[0.8; 2.5]\mu_{s(k)t(k)} + \sigma[0.5; 2.0]\alpha \rceil \tag{6}$$

Further details on the F instances are given here:

Instance	RTT file	No. prizes	Start time	Duration
F1	NW100	300	0	1440
F2	NW100	400	0	1440
F3	NW100	500	0	1440
F4	NW100	500	0	1440
F5	NW100	600	0	1440
F1 ext	NW100	300	0	4320
F2 ext	NW100	400	0	4320
F3 ext	NW100	500	0	4320
F4 ext	NW100	500	0	4320
F5 ext	NW100	600	0	4320

4 Details on the London Instances

The problem instances have been generated from 50 customer locations in and around London. All of the London B and L instances use the same common Road Time Table file. Some of the customer locations occur within the London Congestion Charge Zone and the Road Time Table journey times assume that all vehicles can enter this zone. Note that due to the larger nature of these instances multiple prizes may exist between customer pairs.

4.1 London B Instances

The size of the prizes for these instances has been created randomly using the same formula as for the North-West A instances:

$$p_k = \lceil \sigma[0.8; 2.5]\mu_{s(k)t(k)} + \sigma[0.5; 2.0]\alpha \rceil \tag{7}$$

There are 10 randomly generated problem instances each with the same parameters of:

No. Instances	RTT file	No. prizes	Start time	Duration
10	london	75	360	600

4.2 London L Instances

The London L problem instances use the same specifications as for London B except there are 350 prizes:

No. Instances	RTT file	No. prizes	Start time	Duration
5	london	350	360	600

5 Details on the Small Test Instances

10 small instances have been created for the use in the development phase. They are based on data from the area around Manchester and used the NW25 RTT file.

Details on these instances are given here:

Instance	RTT file	No. prizes	Start time	Duration
test1	NW25	27	200	600
test2	NW25	20	200	600
test3	NW25	18	500	800
test4	NW25	18	500	500
test5	NW25	20	500	800
test6	NW25	15	500	800
test7	NW25	15	500	600
test8	NW25	10	500	600
test9	NW25	10	500	900
test10	NW25	15	500	700